

THE RECENT INTRUSION OF FORESTS IN THE OZARKS

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INTRODUCTION

Scanlan (1950), in writing of American forests, says: "The lumber barons began to despoil and they did an excellent job." This statement might correctly be applied to a specific region but a lumber baron could not operate in a prairie region. Seemingly, it cannot be applied at all to the eastern and northern portions of the Ozarks. Within historic times this vast region was a prairie, or at least park-like in that the trees were widely spaced and confined to the water-courses and drainage-ways. The logging operations which are now so much a part of the industry of the Ozark region are but little more than a century old. The loggers have been, and still are, cutting the first crop of trees to mature there. In some sections any tree large enough to yield a 2 x 4 is cut; and the region will be scoured again and again for more trees of that size. However, there is evidence to show that insufficient time has elapsed to develop a mature second growth of either pine or hardwoods.

During a study of the flora of the northeastern edge of the Ozark Uplift an effort was made to visualize the steps which are supposed to precede the formation of a mature forest—the "climax" of the ecologist. This time-elapse study of only twelve years revealed a speeding succession of plant species not at all approaching the accepted trial-and-error elimination which is supposed to set the pattern for our forest areas. In an effort to reconstruct the Ozark forest before the advent of the white settlements and before logging had progressed very far, a search was made for old trees. After considerable difficulty many old trees were found which bridged the gap between grassland and forests. In one detailed study of a relic (Beilmann, 1943), a ring count gave an estimated age of 327 years. This was a "wolf" tree with heavy lateral branches whose tips touched the ground; it had grown as an isolated specimen and only recently had it any neighbors.

ECOLOGY

Steiermark (1940) made the first critical study of plant successions in the Ozarks. He found and described 164 examples of "large-scale natural plots." According to him, the classical Maple-Beech Climax, as proposed by Clements and Weaver (1929) on the basis of climatic conditions, does not hold in this area. For this he would substitute five edaphic associations based on the physical, chemical, and local moisture conditions. It would seem to be quite difficult to find such vast variation in soils that one might find 164 "associations" based on edaphic conditions alone, unless a certain immaturity was a characteristic of the forest aspect. Steiermark devotes one chapter to "variations induced by burning, logging,

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clearing, and other unnatural causes." For centuries, burning, aggravated by reduced precipitation, governed the distribution of forests. As the area became settled, the decrease in wild fires and the increase in rainfall reduced the loss by fire. Logging and clearing followed, but logging reached its peak in 1900. Therefore, the unnatural causes listed by Steyermark, together with edaphic adaptations, govern the distribution of species in the Ozarks. The writings of the earlier travelers indicate that not nearly enough time has elapsed for the development of either a monoclimate or a polyclimate forest, unless we are prepared to call any group of plants a climate, regardless of how ephemeral the association may prove to be. An ecological study of the Ozark forest must not overlook the short time which has elapsed since the area was either "sterile" or grassland.

HISTORICAL ACCOUNT OF THE OZARKS VEGETATIONAL ASPECT

The Ozark Highlands of Missouri is unique as one of the oldest land-masses of the North American continent. Here on a land of archaic plains, deeply dissected by rivers entrenched in ancient meandering courses, erosion has carved in high relief, the land of rugged beauty we know today. It is only fitting, then, that rooted into a land having such a singular geologic background we find a flora equally interesting. In the Cambrian and Ordovician rocks, which comprise the greater part of the Ozark highlands, the history of the area may be read, and there is little evidence today of the varied floral aspects presented by Ozarkia in times past. However, turning to the diaries and journals kept by early explorers and travelers there is considerable evidence that the vegetational aspect of Ozarkia has never been static, and the rich hardwood forests which today add so much to the beauty of the Ozark mountain region are of relatively recent development.

The early Spanish and French discoverers in the Mississippi and Missouri River Valleys give us the first accounts of the early aspects of the Ozark region. Bearing in mind that the primary interest of those adventuring soldier explorers was the discovery of land rich in precious metals for the crown and that they were interested more in fruits and edible herbs, wood for fuel, and the construction of boats and simple fortifications than in botany, it is understandable that only a scant record was made of the native vegetation. The general structure of the Ozarks is of Cambrian and Ordovician rocks of more or less uniform composition, and a general habit for the whole region may be assumed on the basis of material reported from relatively localized areas, except where special modifications due to soil and water are noted.

The Ozark area was discovered by Ferdinand DeSoto in 1541 and included in the region then known as Florida. Houck (1908) believes DeSoto entered Missouri from Arkansas and, because of the numerous swamps of the region, took advantage of the highland now known as Crowley's Ridge. It was from here that the hearts of the travel-weary soldiers of DeSoto were lightened by the sight of the village of the Casquins. We are told that the fields upon the rich alluvial bottoms were planted in maize, and the pecan, plums, and mulberry trees were abundant. That

it was possible to see the distant village can only have meant that the soldiers were in an open, very park-like country unlike the dense forest of hardwoods that cloak this region today.

In the narrative of Garcilasso de la Vega, chronicler of the DeSoto expedition, we learn that DeSoto sent two of his men, accompanied by Indian guides, forty leagues to the north seeking salt and precious metals. The men returned eleven days later laden with salt and copper, but spent and famished. They reported that the country, indicated by Houck to have been the highlands and headwaters of the St. Francis River, was sterile and thinly populated. Indians of that region informed them that the country farther north was almost uninhabited, and that the interior of the Ozarks was even more sterile. Leaving the land of the Casquins, DeSoto marched southwest into the bottoms of the Little River. Here the gentleman of Elvas, also a chronicler of the DeSoto expedition, tells us of a land "full of good meadows on the river," from which only recently a vast forest has been removed. Quitting the swampy lowlands country in tireless quest of gold, DeSoto and his men marched northward toward Caligoa, believed by Houck and supported by Nuttall and Schoolcraft to have been the elevated highlands between the Black and St. Francis rivers, and at that time a land devoid of timber where herds of buffalo roamed. In the swampy lowlands and on the loessial hills bordering the Mississippi River, a more park-like aspect prevailed, as indicated by Garcilasso's description of the country of the Casquins.

Coronado, in 1541, is believed to have reached the southwestern portion of Missouri (Houck, 1908). The prairie aspect is indicated there by his notation of a rolling grassland, well watered with many rivers, and Osage Indians hunting among the vast herds of buffalo.

After DeSoto and Coronado, a period of French explorations begins. Entering the Mississippi Valley from the Great Lakes Region and seeking a water route to the Vermillion or Indian Ocean, the explorers travelled chiefly in bark canoes upon the rivers, and acquired little knowledge of the interiors. Father Membre, accompanying LaSalle down the Mississippi in 1683, has pointed out that the groves were so open and unobstructed one could ride through them on horseback. But even in those early years the appearance of Ozarkia was changing rapidly. Joutel, writing of the vicinity of Saline Creek in 1687, says: "The country was full of hillocks, covered with Oak and Walnut trees, and an abundance of Plum trees . . ." (Houck, 1908). Already we see indications of the encroaching forest. However, the forest was still conspicuously park-like, and Father Vivier in 1750 writes:

Both banks of the Mississippi are bordered throughout the whole of its course by two strips of dense forests, the depth of which varies, more or less, from half a league to four leagues. Behind these forests the country is more elevated, and is intersected by plains and groves, wherein trees are almost as thinly scattered as in our public promenades. This is partly due to the fact that the savages set fire to the prairies toward the end of autumn, when the grass is dry; the fire spreads everywhere and destroys most of the young trees. This does not happen in places nearer the river, because the land being lower and consequently more watery the grass remains green longer and less susceptible to the attack of fire. (Houck, 1908).

As late as 1789 Forman was told by Captain Foucher, Spanish Commandant at New Madrid, that he could drive a coach-and-four through the open woods from New Madrid to St. Louis. It was inevitable that a resident population be attracted first to the eastern border of the Ozark region, and it was about 1704 that the first settlers made their home in the vicinity of Ste. Genevieve (Sauér, 1920). Here, conveniently located to Indian tribes and the fur trade, with an abundance of salt close at hand, and with the Arcadian abundance of the land, they had an easy existence. Trading in furs and mining for lead occupied most of their attention, but of this period we have only scattering impressions of the aspect of Ozarkia.

It was not until the cession of the Louisiana Territory to the United States in 1803 that any real consideration was paid to the resources of the area. Then, as in earlier years, an "open aspect" of the Ozarks predominated. The uplands in the interior were a rich grassland and supported numerous species of the "broad leaved" herbaceous plants. Numerous barrens were found in the dolomitic and porphyritic hills, and there the vegetation was sparse. At this time trees were, for the most part, found only at wide intervals bordering the water courses, in deeper and richer soils of the uplands as isolated specimens, or occasionally in small park-like groves. In a sketch of the Louisiana territory, Major Amos Stoddard, who had accepted the land in the name of the United States in 1803, writes: "The highlands are seldom so thickly covered with wood as to prevent the growth of grass. They exhibit more an appearance of extensive meadows than of rude and gloomy forests."

In 1819 Schoolcraft, who toured the Ozark region on foot studying the mine country, was also impressed with the openness of the area, and observed:

The general aspect of the country is sterile Respecting the botanical character of the mineral soil, it may be further observed that although it yields but few forest trees, and they are not of a vigorous growth, yet a botanist might find his labors well rewarded by the profusion of shrubs and wildflowers which are everywhere found on the barrens.

In regard to the region between Herculaneum and the Meramec River, which today supports notable timbered lands, Schoolcraft (1819) noted:

Our road this day has lain across a sterile tract of country, consisting of a succession of hills of moderate elevation, covered chiefly by oaks and without underbrush. A tall, thick, and rank growth of wild grass, covers the whole country, in which the oaks are standing interspersed, like fruit trees in some well cultivated orchard, and giving to the scenery the most novel, pleasing, and picturesque appearance.

And this was a general condition, for he describes the country in the vicinity of Bourbon thus:

Our route this day has been over barrens and prairies, with occasional forests of oak, the soil poor, and covered with grass, and very little underbrush. As evening approached we entered the valley of the Merrimack, which we followed up for several miles, and encamped in a prairie near its source. Some good bottom lands are found on its banks, but the adjoining hills are stony and barren, covered with little timber and high grass. (Schoolcraft, 1821).

Bradbury, who traveled the Ozarks concurrently with Schoolcraft, wrote:

The general character of this country is that of prairie, with scattered trees and interspersed clumps The tract of country which contains the mines is very uneven, consisting of high narrow ridges, separated from each other by deep craggy glens; the ridges have a peculiarly bald and arid appearance (Bradbury, 1819).

The exploring expeditions sent out after the Louisiana Purchase were bound for the mountains, prairies, and deserts of the Far West and they give little first-hand information of the Ozark country. However, Dr. Baldwin, accompanying the Long Expedition as Botanist on its western explorations in 1820, has left some impressions of the country in the vicinity of St. Louis. Collecting plants in the region of the mouth of the Meramec River, Dr. Baldwin found a typical prairie flora, and noted: "The grassy plains to the west of St. Louis are ornamented with many beautifully flowering herbaceous plants The borders of this plain begin to be overrun with a humble growth of Black-jack and Witch Hazel." (Baldwin, 1823).

Twenty years later we find the openness of the Ozarks still prevalent, as Davenport (1842) tells us: "There is no part of the globe, in a state of nature where greater extents of country can be traversed more easily, and in any direction, by carriages of any description." Featherstonhaugh (1844) describes the region near Herculaneum after climbing a rugged hill: ". . . . at the top of which we found ourselves in extensive barrens containing straggling trees."

During a period of settlement in the Ozark area, indicated by Sauer to be about 1820-1850, we find indications of the forest slowly and surely encroaching upon the prairie grasses dominant for so long a time. Settlement and the reduction of prairie fires favored the development of a forest flora as Swallow (1859) points out:

The slopes and some of the highlands are covered with heavy forests of nearly all the trees found in the bottoms But a still larger part is sparsely timbered forming the beautiful oak openings. This stunted growth is not, however, due to the poverty of the soil, but to the fires which have annually overrun this country since the earliest dates of the Indian traditions.

Jewett (1866), reporting on the agriculture of Jefferson County, writes: "The country is entirely covered with timber, except where improved the Oaks and Hickory predominating." Elsewhere woody growth was seen invading the prairies. Broadhead (1873) reports on Barton County: "The first signs of a growth of timber on the prairies is the appearance of small Persimmon bushes. They are common nearly everywhere"; and, "In southern Missouri open prairies are rare, but in their stead are occasional large tracts of barrens, or hilly districts covered with tall grass, on which are scattering stunted Oaks" Sargent, in 1884, notes: "A gratifying improvement in the condition of the forest in the parts of the state first settled has followed the enactment of a fence law preventing the general ranging of stock through the timber land."

Toward the close of the nineteenth century we find growing concern over future timber supplies for extensive lumbering, and the widespread use of wooden ties for a rapidly expanding railroad system was making noticeable reductions upon a forest which was still somewhat open. However, Shepard (1898) reporting on the geology of Greene County writes:

It is a mistaken idea that the supply of timber in this region is decreasing; on the contrary it is largely increasing. Attention was first called to this fact by Mr. J. W. Blankinship who has given a great deal of study to the flora of the region. He learned from the testimony of old settlers that seventy years ago there was probably not one-half the timber in the country that there now is It has probably increased one-third within the last forty years.

When Henry Shaw first visited the area which is now the Missouri Botanical Garden in 1820, he observed that "for a distance of two miles no trees were growing The prairie was grown over with a tall, natural grass." (Shaw, 1880).

Thus we see that the encroachment of forest upon the ancient prairies has been rapid indeed and that our forests as we know them today are of relatively recent origin. The barrens which were conspicuous in earlier times in their paucity of vegetation have remained as "islands" included within the forests, and are observed as botanical and geologic oddities.

PRESENT FOREST RESOURCES

King, Roberts, and Winters (1949) point out that "Missouri's forests are largely composed of immature stands" and that only 14 per cent of the "land bearing or capable of bearing commercial timber" supports stands of saw-timber value. In a summary they state that 43 per cent is in pole timber, 32 per cent in seedlings and saplings, and 12 per cent is poorly stocked. Thus, nearly 90 per cent of the commercial forest land is in immature stands. The saw-timber averages only 789 bd. ft. per acre; 5 per cent of the forest land supports 3,000 ft. per acre; and an additional 10 per cent, 2,000 ft. per acre. They also point out that one-third of the gross value is in cull trees and unmerchantable species. In addition, the net growth per acre is estimated at 38 bd. ft. in the Ozark region and reaches only 59 bd. ft. in the river-border region. They suggest that the commercial forest land might ultimately produce three times the present value of growth under good management.

The Ozarks as a forest region is disregarded by Cheyney (1942), and the species of trees growing there are included among those of the forests of the Lake states and of the Atlantic and the Gulf Coastal Plains. Apparently, the bd. ft.-production per acre is so low that logging has not developed to the magnitude found in other areas. Even today, it is a region from which much of the output of the saw-mill goes into specialized products. Logging is reported to have reached its peak in Missouri about 1900, when 1,169 saw-mills produced three-quarter billion board feet of lumber, and approximately three million cross-ties. From such figures it is apparent that within the space of fifty years most of the merchantable timber in the state was logged. At present, the net growth of the growing stock exceeds the cutting drain by only 1.8 per cent annually. At this rate, it would take 225 years to support five times the present volume of saw-timber. The logging industry revolves around a vast number of small mills operating seasonally. There is no evidence that the type of logging has changed greatly in the last fifty years. The backbone of the lumber industry at present is the 1,585 mills or 56 per cent of the total in the state, which produce 68 per cent of the total lumber. Many of these are under-powered and poorly equipped. Their annual cut ranges from 50,000 to 500,000 bd. ft. each, and there are only 45 mills which cut more than a million board feet annually.

The complete picture of the saw-milling operation in Missouri does not convey the impression that the Ozarks were once stocked with magnificent forests. Only fifty years have elapsed since saw-milling reached its peak, and less than 150 years since the first logging camps were established on the headwaters of the Gasconade River. Due to the transportation difficulties before the advent of the railroads and to an uncertain market, the earliest lumber operations largely served a local territory. These factors would have tended to conserve the resources in the early stages. Later, of course, improved transportation made the products of the Ozark saw-mills available throughout the Middle West. This would also have favored an increase in the annual cut which reached a peak 50 years ago and was not approached even during the favorable years of 1940 to 1946.

THE RED CEDAR

At one time the scarcity of fencing material was considered a handicap to the settlement of the western country. Since such huge quantities of cedar posts are available and are so generally used in fencing today, we may wonder what position the Red Cedar (*Juniperus virginiana*) occupied in the early forests. Stoddard (1812) found, "it in plenty on the banks of the Mississippi and some other rivers above the mouth of the Illinois." Brackenridge (1817) found it on the Meramec, St. Francis, Missouri, and the Mississippi—"some very large islands on the Missouri are covered with this tree." It is very likely, however, that the "cedar" of Brackenridge was the Bald Cypress (*Taxodium distichum*) and not the Red Cedar (*Juniperus virginiana*). Bradbury (1819) found it along the Gasconade and Missouri River bluffs and mentions "that the tops are crowned with Cedars." Swallow (1855) places its habitat as the "dry limestone bluffs." Broadhead (1874), writing of Madison County, said that "Cedar Creek contained some of the finest groves in the state." He also mentions that great quantities have been cut for fence posts from the vicinity of Leatherwood Creek and Gray's Mountain.

Between the time when fencing material was scarce to the time of Broadhead's observations, there are not many references to this tree. From this we might infer that the species was not nearly so conspicuous as it is today. It would have been impossible for it to have escaped the attention of Featherstonhaugh. Today *Juniperus virginiana* is one of the most common trees in the Ozarks, and on the northern edge it has taken over the role of pioneer and invader. It very often precedes the elm, persimmon, and sassafras trees which Swallow (1855) reported as "not common." The Red Cedar is quite shade-tolerant and will persist in grassland until a favorable opportunity for rapid growth arrives. It is one of the major competitors of old established trees. The seeds, voided by birds, germinate in all fence corners, open fields, and in the soil beneath the branches of any tree under which they happen to fall.

This vigorous encroachment on fields and timber land by the Red Cedar appears to result from the control of fires. There are few species of trees more susceptible to fire injury than this tree. The annual burning of fields and woods which was

so very common until just recently would have kept it within bounds. Beecher (1950) writes that the junipers (Red Cedars) were hardly known in Franklin County in 1900, and that when needed for Christmas decoration it was necessary to cross the Meramec River into Jefferson County to find suitable specimens. Today this species has gone north of the Missouri River and appears altogether too often on the grasslands in Callaway County. Unless burning is practiced, the Red Cedar has demonstrated that it can, in a short time, become the dominant tree in the entire Ozark region.

SOILS AND EROSION

Extraordinary efforts are being made throughout the country to prevent erosion and retain the topsoil. It is stated again and again that the early settlers "mined" the soil and then moved on to new land to repeat the process. However, travelers have left a description of the original Ozark soil, and it appears to have changed very little. Schoolcraft (1819), in his "Tour of the Mine Country," reported the "soil as a reddish coloured clay, stiff and hard, and full of fragments of flinty stone, quartz, and gravel: this extends to a depth of 10 to 20 feet, and is bottomed on limestone rock." Bradbury (1819), traveling through the Missouri Territory, noted that "the stratum immediately below the vegetable soil is almost universally a very tenacious clay and extremely well calculated to form a material for bricks." His prediction is borne out by the extensive clay-products industry which has developed through central and eastern Missouri. James (1823) described the Loutre and Grand prairies in Warren and Montgomery counties as having a soil which "was not very good; but mixed at the surface with so much vegetable matter, accumulated by the successive growth and decomposition of the yearly products, as to give it the aspect of fertility." This observation is especially interesting, since these counties are still predominantly grasslands.

Obviously there has never been a deep, rich topsoil capable of supporting an intensive kind of agriculture in the Ozarks. Nor, can any evidence be found to indicate that these soils ever approached typical forest soils—the podsollic soils of the north on which good forests are found. Rather these soils approach the Groot soils, the nut-structured Prairie-Forest soils (Wilde, 1946), or the "Lime Prairies" (Hilgard, 1906), described as a clay soil overlaying weathered limestone. Wilde points out that the transitional prairie soils present a picture of a struggle between grass and trees and that "this struggle does not end even when the forest canopy is closed over the prairie soil." He further states that the struggle "involves not only plants, but animals and lower organisms as well."

Although it appears that the Ozark soil has always been much like the soil we know today, erosion may have increased in the past few years, if we recall Seay's (1866) observation on the absence of ditches in Crawford County. Perhaps the "newness" of erosion as a possible factor in Ozark land use is best illustrated by the numerous earth mounds thrown up by the Mound Builders. Houck (1908) was able to locate 28,000 mounds in Missouri. These earthworks, laboriously con-

structed by a prehistoric people, required the moving of millions of cubic yards of soil. To have succeeded in such a gigantic undertaking, each basket of soil carried to the top must have remained in place. The mounds could not have been built during a period of rapid erosion. The years during which they have been exposed to all weathering agencies is indicated by Houck, who states that the Indians found by the first white explorers did not recognize the mounds as their property nor did they use them or have any traditions concerning their origin. Stoddard (1812) says that they "have endured for centuries. The trees on their ramparts . . . indicate an age of more than four hundred years." Pustmueller (1950), describing Monks Mound, states that "most of the trees have grown large in recent years, for at one time it was nearly bare." Only lately have the members of the St. Louis Archaeological Society been concerned over the destructive action of erosion, although the mounds have been a part of the Ozark landscape (Walker and Adams, 1946) for centuries. Now, after eight centuries, Monks Mound, rising over 100 feet above the adjoining country, is being slowly destroyed by gullies.

FIRES

Few travellers have written as vividly about Ozark fires as Featherstonhaugh (1844), who measured the progress of a fire at a camp eight miles from the Current River. He mentions that hunters used fire to drive game, and that in consequence of camp fires being left burning, "many thousands of acres were burnt over." In approaching Little Rock he expressed concern lest he be caught crossing a valley in which a fire was raging. Certainly, these fires have been common in the whole region from the earliest times. Swallow (1859), in his report following a railroad survey, describes central and southwestern Missouri as "in large part sparsely timbered, forming the beautiful *oak-openings*. This stunted growth is not, however, due to the poverty of the soil, but to the fires which have annually overrun this country since the earliest dates of the Indian traditions." Annual burning would have given the grasses and herbaceous plants every advantage by destroying the woody plants as well as the seedlings. Featherstonhaugh expressed the opinion "of Mr. Jefferson and others that all prairies have been produced by the Indian practice of firing annually, and thus destroying the grown timber as well as inferior plants."

Fires are probably an extremely important factor in the maintenance of the openness of the country, and may have aided indirectly in the production of tremendous quantities of seeds and fruits. Later, as the country became populated and the settler had much more to lose, the practice of burning annually was frowned on. A fire advancing on a homestead, as described by Featherstonhaugh, could destroy the cabin, whatever stock of grain the settler had, and, by destroying his fences, leave the fields open to the roving game and cattle. Even today the burning of woods is carried on only in those "backwood" areas where a kind of subsistence farming exists.

Officials charged with fire control have long since learned that the native backwoodsman considers burning the woods his prerogative, and he cannot be convinced that he is doing harm. When apprehended he is able to offer only a few "lame" excuses; among them, he wishes "to increase the grass" or "destroy the insects." When we consider that these people, the direct descendants of the first white settlers, are almost inarticulate with strangers, and especially in a court of law, it may not seem so extraordinary that they are unable to convey their knowledge handed down through the years, of the openness of the timber and the grazing which was once available to cattle. Their insistence that they can "improve the grass" is not without foundation, since they alone have more than an academic connection with the past. There are no fires in the sections where farming has developed sufficient stability, and where there are only remote or no ancestral connections with the past.

Swallow (1859) clearly indicates that a reduction in fire would result in an increase in timber. Sauer, illustrating the early opinion that fires checked tree growth, quotes the refusal by the United States of a grant of land to raise timber, on the ground that "it is only necessary to keep out the fires to cover the prairies with timber by the operations of nature." Along the northern edge of the Ozarks, fire protection favors the woody plants to such an extent that fields are completely reseeded in just a few years. The American Elm (*Ulmus americana*), Red Cedar (*Juniperus virginiana*), Soft Maple (*Acer saccharinum*), and locally the persimmon (*Diospyros virginiana*), and sassafras (*Sassafras albidum*) are all invaders of abandoned fields which have been given fire protection. These species can maintain themselves after gaining a foothold, but can be seriously injured and set back by fires at any time in their early years. If fire is allowed to enter such a field the reduction in growth rate follows a pattern so frequently described in present-day conservation literature. It is noteworthy that the light-seeded trees are the invaders of open ground, and not the oaks whose heavier seeds are probably planted by the smaller animals. If the oaks were the dominant trees of the area, and they are so described by both Swallow and Featherstonhaugh, they would spread rather slowly from the parent trees. This would indicate that the invasion rate a century ago was very much slower than it is today where fruiting specimens of light-seeded trees can be found in every ditch row, and where protection from fire favors their rapid spread.

RAINFALL AND SALINES

The early travelers spoke very highly of the healthful Missouri climate, but it is not possible to learn from the Weather Bureau records whether there has been any major change in the last century and a half. The records of the St. Louis office go back to 1837, but they do not show any pattern in the distribution of rainfall. For instance, in November, 1865, not a drop of rain fell, while the maximum for November is 8.63 inches in 1847. December records show as little as .18 inches of rain and as much as 10.90 inches. July and August are usually

drier with a minimum of .25 inches for July and .07 inches for August. The maximum is 20.45 inches for August 1946 and 9.50 inches for July 1875. This wide variation in precipitation serves only to demonstrate the limited value of precipitation records in so far as plant growth is concerned, and all efforts to discover trends toward an improvement or deterioration in climate have been unsuccessful.

There must have been an appreciable increase in annual rainfall to have favored the explosive invasion of the grassland by the trees. Much less rainfall is needed to grow good grass than trees, and it is only necessary to observe the area 400 miles west of St. Louis to see a first-hand struggle between grass and trees for the available moisture. Raup (1937) is convinced that the prairies at one time extended as far east as the Hudson Valley.

If there has been a great increase in precipitation, it probably occurred just before the establishment of Spanish colonies in the Mississippi Valley. Of Marquette's description of the Mississippi in the vicinity of Grand Tower, Houck (1908) writes:

It is quite evident that Marquette here refers to the stretch of river about Grand Tower, although it does not exactly describe the present condition. But 225 years will effect great changes, and that the river has widened in that period and that some rocky obstacles have been washed away is also certain.

The seasons at that time appear to have become wetter. Since precipitation records are of no value in furnishing the needed information, it becomes necessary to rely on the early writers for proof. Featherstonhaugh (1844) wrote that "at one time voices could be heard across the Mississippi at St. Louis"—a far smaller stream than the Mississippi of today!

One of the important occupations of all settlers and travelers was the procurement of salt. From the time DeSoto sent some of his party north for this purpose until almost two centuries later, when Moses Austin (1797) reported that the salt works, "when extended, might furnish all the upper settlements on the Mississippi," the evaporation of salt was a major project. In 1799, the works on Saline Creek in Ste. Genevieve County, produced 956 bushels of salt. Daniel Boone operated a salt lick which became sufficiently famous to lend its name to a major highway west—Boone's Lick Road. The fastidious Featherstonhaugh often refused the rough fare made available to travelers because much of the salt in use was gathered with a spade from a "lick," and both the salt and the soil was added to the cooking. Schoolcraft reports a salt lick near the present site of Fenton and two salt-manufacturing operations nine miles from Herculaneum. He mentions another salt-lick in the Bellevue Valley, and he describes a buffalo lick called Bates' Lick covering about twelve acres and worn by game to a depth of ten or twelve feet.

Although modern industry has supplanted the old iron kettle and evaporating pans and now supplies a very high-grade salt, the "licks" have vanished. It would seem that there are only two possible causes for their disappearance: (1) The rainfall may have increased so much that the brackish water is being diluted, and

the water of today could not be used in the crude evaporating pans; (2) The growth of timber has greatly reduced the flow from springs, with the result that those which were used as sources of salt have now dried up or flow intermittently only during wet weather when the "salty" character would go undetected. The smaller springs, perhaps flowing seasonally, furnished the supply of salt for the "licks" used by both the game and the travelers.

It is well known that the maximum amount of percolation occurs on a good sod where run-off is reduced to a minimum, while a very appreciable part of the rainfall striking the forest cover is evaporated. Edward Clark, in a personal communication, expressed the thought that the disappearance of the salt licks might be partly due to increased precipitation. Wolff (1948), working in the drier climate of Oklahoma, has shown that restoration of grass cover increased the flow of springs which had been checked by the advancing timber line. In his work with "cedar brakes" on the Edwards Plateau he was able to restore intermittent springs to full-time flowage by removing the cedars from the watershed and re-seeding to grass.

It would seem that a climatic change tending toward increased precipitation has occurred in the Mississippi Valley and the near-by Ozark highlands. In a report on Crawford County, Seay (1866) states:

The valleys are frequently wide, scarcely ever rocky, covered with grass or hazel, with a deep, loose, sandy soil, and generally no definite channel to them. The water, if it accumulates rapidly, washes over the whole ground, but hardly ever so as to do any serious damage; and [in] an ordinary wet spell the water never finds its way out, but sinks.

It would hardly seem necessary to point out that there are few if any valleys in Crawford County today that are not bisected by a drainage-way in the form of a fast eroding ditch. The salt "licks" have disappeared and the forest has invaded the grass land. The additional rainfall may have been all that was needed to support trees. It has been demonstrated (Wolff, 1948) that a tree cover reduces percolation and reduces the flow of springs, while a grass cover, checking run-off, favors percolation and ground storage of water.

SEED PRODUCTION

Assuming that the Ozark highland experienced less rainfall two centuries ago than today, the leaching of soluble plant food would have been reduced to a minimum. This would have assisted in maintaining fertility at a fairly high level, which could be expected to stimulate seed production. Foresters have long been familiar with the "good" seed years which follow a severe drought. Kraus and Kraybill (1918) have shown that fruit production is correlated with the carbohydrate-nitrogen ratio. Klebs (1918) points out that during a hot, dry summer there is an excess production of carbohydrates in relation to the nutrient salts. This "in turn increases the probability of flower formation." Heyward and BARNETTE (1934), investigating the effect of fires on the chemical composition of forest soils, stated:

The soils subjected to frequent fires were found to be consistently less acid, and to have higher percentages of replaceable calcium and total nitrogen. An indication was found that these burned soils were also characterized by larger quantities of organic matter as judged by loss on ignition.

The above investigations would serve to show the seed production potential of the Ozark area. With the trees widely scattered, a reduced precipitation, a minimum of leaching—all factors favoring flower formation—the stage was set for the production of heavy seed crops. That seed production was very heavy is convincingly shown in the early records. Audubon (Wilson and Bonapart, 1831) observing a flight of Passenger Pigeons, estimated that they consumed more than 17 million bushels of grain daily.

In 1700 Father Gravier (Houck, 1908) killed two bears in Scott County and saw fifty more cross the Mississippi River during one day. In the first statistical report of the Spanish settlement at St. Louis and Ste. Genevieve, Piernas (Houck, 1908), in 1772, listed 905 packs of furs shipped to New Orleans. These few citations, among many, indicate that the game "carrying capacity" of the region was tremendous. It follows, then, that the production of food must have been in keeping with the needs of the game, also that a vast assortment of food was available. Few of these game birds and animals can be found in the wooded Ozarks today. Not even the turkey, when given full protection, has staged a comeback.

Even though the Ozark woodland is rated as "understocked," we find trees growing so close together that very few individuals produce a crop of seed. The plum thickets at the edge of the woodlot and some of the smaller shrubby plants may seed annually, but the heavy production of mast on which the pioneers fattened their hogs is a thing of the past. Only those oaks which are growing as isolated individuals bear seed with any degree of regularity. Lawn trees and scattered oaks near the Arboretum nursery mature seed quite regularly, some individuals bearing heavy crops in alternate years. Many oaks in the forested areas have not produced seed in ten years, although they have been carefully watched since seed collections were needed to complete certain taxonomic work. Most of the trees submerged in the Ozark forest bear very infrequently, and some individuals apparently never set fruit. This would appear to be in contrast to the behavior of these same species a century or more ago. In a region of reduced rainfall and no leaching, one would expect a favorable balance of carbohydrate to nitrogen. Annual burning would have made plant food readily available. Widely spaced trees would have produced a maximum crop of fruit.

Tree fruits were not the only source of food. Many of the larger animals grazed as much as they browsed on the trees, or pawed the forest floor for acorns as do the deer today. This would suggest that the grassland contained a vast variety of species other than the Gramineae. Probably many of these were legumes stimulated by the same conditions which produced heavy "mast" yields from the scattered trees which were the early forests.

BEES

Native flower pollinators in the form of Bumble and Solitary bees of the genus *Megachile*, *Nomia*, *Osmia*, *Andrena*, and *Bombus* must have been present from the earliest times until destroyed by modern agriculture. However, Bradbury (1819) reports that the Honey Bee (*Apis mellifera*) crossed the Mississippi River in 1797 and moved westward 600 miles in the succeeding fourteen years. According to him, this "extraordinary progress in these parts is probably owing to a portion of the country being prairie, therefore yielding a succession of flowers during the whole summer which is not the case in forests." He points out that the Indian believed that when the Honey Bee appeared, the white man was not far behind.

The flora of the prairie must have contained many kinds of plants other than the grasses to have favored the astonishing increase and progress of the bee. Grass alone would not have supported the bee, nor would a forested region have furnished more than suitable colony sites. The vast quantities of game, both animals and birds, indicate that there was a heavy production of fruits and seeds. Modern beekeeping depends very largely upon the legumes as a source of nectar. To have produced the vast quantities of high protein foods required by the game, the country could not have been heavily forested, and the legumes must have made up a very appreciable part of the flora.

HISTORIC FLORA

Much has been written of the early vegetational aspects of the Ozark area, but there is only a scant record of specific plant material. However, the material available substantiates the vegetational aspect recorded of that time. For earliest records we must lean heavily upon Schoolcraft (1819, 1821) and Bradbury (1817) whose interests in natural history enabled them to record many valuable observations. Following them, the botanists Nuttall, Baldwin, and James, attached to westbound exploring parties, have left valuable notes on this early flora. However, as their route of travel lay along the Missouri River, they recorded little of the interior of the Ozarks. Tracy (1886) wrote the first flora of Missouri but admitted that, due to difficulties of travel and lack of sufficient field material, he had not included all the plants which probably grew in Missouri.

Naturally the attentions of the first travelers were attracted to the arboreal flora, for in a region of extensive prairies the presence or absence of trees for fuel and lumber was a deciding factor in the settlement of the region. Stoddard (1812) pointed out that the city of St. Louis may never grow to the west because the expanse of prairie there did not provide enough wood for fuel and fencing. Although the composition of the forest flora has not changed to any great extent, change is noted in a greater number of trees. Early travelers found nut-bearing trees and hardwoods on the ridges and prairies where the heavy growth disfavored the light-seeded trees. In the lowlands, rich alluvium and inundation permitted the growth of light-seeded trees. Bradbury (1817) found:

On the summits of the ridges, the timber is generally red cedar; on the prairie, post oak, black-jack oak, black walnut and shell bark hickory. The alluvion of the rivers contains a great variety, of which the principal are cotton wood, sycamore, over-cup oak, nettle tree, hoop ash, honey locust, black locust, coffee tree, pecan, and many of the trees common in the states east of the Alleghanies.

Stoddard (1812) found the Sugar Maple abundant near Cape Girardeau and the people making large quantities of sugar from the trees. He observed persimmon, mulberry, chestnut oak, iron wood, and crabapple growing on the "high ground" and noted: "Common to both the high and low grounds are sugar trees in abundance, several kinds of walnuts, several kinds of hackberry, cherry, buckeye, black and honey locust, three kinds of elm, gum tree, lyn, sassafras, nine bark, spice and leatherwood, two kinds of ash, and the coffee tree."

All the early settlers agreed that the Post Oak (*Quercus stellata*) was the most common tree scattered about the prairies. Schoolcraft (1819) writes of the Post Oak: "They are seldom found to grow higher than 30 feet, and 40 is the highest, seldom exceed a foot in diameter, and stand scattering." The Black-Jack and Shingle Oak also seem to have been common trees of the uplands.

Wild plums in thickets were common and prized for their fruit, as Brackenridge (1817) noted:

Amongst the wild fruits of Louisiana, the plum has been celebrated there is none more interesting than the prairie plum, *Prunus Chickasa* [probably today our *Prunus angustifolia*], which literally covers tracts of ground of many acres in extent, and produces fruit so abundantly as to bend down to the earth with its weight.

Frequent references to the crabapple and hawthorns are to be found. As late as 1908 Sargent found the Ozark region a rich field in which to work as he monographed the genus *Crataegus*. These plants are not so conspicuous today and the recent invasion of the Red Cedar may be a factor in the failure of this genus so susceptible to the cedar rusts.

Wild grapes were common everywhere, and the vines were far larger than any we know today. Swallow (1859) measured vines from 22 to 27 inches in circumference, and 55 to 120 feet in length. Bradbury (1817) found a vine, near the Meramec River, 37 inches in circumference.

The rich prairie flora drew little comment from the earliest travelers. Schoolcraft (1819), however, remarks: ". . . a botanist might find his labours well rewarded by the profusion of shrubs and wild flowers which are everywhere found on the barrens." He was impressed with "sensitive brier," probably *Schrankia Nuttalli*, and mentions the peterswort, upland dock, and smartweed. Bradbury's list of plants found in the lead mine country included 75 species (Bradbury, 1817), and Thomas Nuttall was introducing "interesting plants" to Fraser's Nursery out of the Upper Louisiana Territory in 1813. Baldwin's (1823) notes are among the earliest specific references to the flora of the region, and he collected near the mouth of the Meramec: "*Rudbeckia hirta*, and *R. purpurea*, a small white flowering species of *Houstonia*, *Galium tinctorium*, *Smyrnum aureum*, a Phlox, a new species of *Potentilla*, a *Conyza*, the *Trifolium reflexum*, . . . *Campanula*

perfoliata, *Diospyros virginiana*, *Rhus glabra*, and many others." On the grassy plains west of St. Louis Dr. Baldwin observed "*Aristolochia Siphon*, *Syripedium spectabile*, *Lilium catesbeiana*, *Bartsia coccinea*, *Triosteum perfoliatum*, *Cistus canadensis*, *Clematis viorna*, and *Tradescantia virginica*." A notable feature of these early lists of plants is the consistent inclusion of the Leguminosae. Considering the great abundance of wildlife dependent on plants of this family for food, and the rapidity with which the Honey Bee spread, it is believed that the legumes were an important constituent of the early prairie flora, as they are today in most successful range growths.

Swampy lowlands of the southern Ozarks supported the impenetrable "brakes" of the giant cane (*Arundinaria macrosperma*), popular retreat of game of all sorts. Featherstonhaugh found it to be one of the favored haunts of the black bear. The settlers generally thought that the tender new spring shoots of the cane formed a superior pasture for livestock. (Schoolcraft, 1821; Featherstonhaugh, 1844). The cane has a very limited distribution today.

The joint-reed or rush (*Equisetum hyemale*) was common in the more northern parts of the Ozarks. Bradbury (1817) observed of it:

The rushes, *Equisetum hyemale*, were so thick and tall that it was both painful and difficult to walk along, even at a very slow pace the rushes are valuable, affording to the first settler winter food for his cattle for several years, after which they perish, being destroyed if fed on during the winter.

The tall, lush grasses of the prairies were impressive to all the travelers. Schoolcraft described them as "often as tall as a man on a horse," yet we find few records of their identity. Tracy (1886) wrote: "When the state was organized, our hills and prairies produced an abundant growth of buffalo grass which soon gave place to the blue joint which is, in turn, being driven out by the more valuable blue grass." It is significant that the buffalo grass is not listed in Tracy's flora, though C. S. Jeffries (1888), in a letter to Dr. G. Hardeman of Gray Summit, states that it was common in the area about 1876. Broadhead (1873) points out that the blue grass "grew well after the prairies have been grazed down."

GAME BIRDS AND ANIMALS

The open and park-like aspect of the Ozark region was further evidenced by the great herds of buffalo, elk, deer, and the flocks of turkeys, grouse and quails which the area supported. Certainly this was an important factor in the early settlement of the region, for nowhere in the middle-western country was a human existence made easier than here in the abundance of game, wild fruits, and clear springs and streams. These habitants of a prairie or park-like region bear vivid testimony of its high virginal fertility and productivity—a striking contrast to the low-carrying capacity we experience today.

That the wildlife was one of the dominant features of this region is indicated in some of the earliest writings. Garcilasso (Houck, 1908), recording the DeSoto expedition in 1541, tells us that in the Ozark country the buffalo were so numerous that the Indians did not cultivate corn but rather lived upon game. Con-

sidering the crude hunting arms of that time, game must have been abundant. Father Membre, accompanying LaSalle, wrote of this area: "The fields are full of all kinds of game, wild cattle, stags, does, deer, bears, turkeys, partridges, parrots, quails, woodcock, wild pigeons, and ringdoves." (Houck, 1908). In 1710 Father Vivier writes of the game, "the plains and forests contain wild cattle, which are found in herds; deer, elk, and bear Nowhere is game more abundant; from mid-October to the end of March the people live almost entirely on game, especially on wild ox and deer." (Houck, 1908). The "fields" of Father Membre, and the "plains" of Father Vivier clearly reflect the close relation of these vast animal numbers to the prairie habitat.

The very important part that trade in furs played in the economics of the early colonies may further illustrate the ease with which pelts were secured. Piernas, in his first and third Detailed Statistical Reports for St. Louis and Ste. Genevieve, reported 914 packs of furs in 1772, and 2,888 packs in 1774, sent to the capital, then at New Orleans. (Houck, 1908). Nor was game pursued for furs alone; much of the meat was "salted down" in the centers of large canoes, then known as "pettyaugers," hollowed from large cottonwood trees and often 50 feet long. Much meat was supplied to New Orleans in this manner (Houck, 1908). Birds, too, were present in overwhelming abundance. Bossu traveled in the neighborhood of the St. Francis River in 1764 (Houck, 1908) and found it difficult to sleep at night on account of the noise made by the great numbers of ducks, geese, swans, and cranes in these marshy areas. Perhaps no wildlife spectacle has ever equalled the prodigious numbers of the passenger pigeon described by Bossu as often eclipsing the sun. Audubon reckoned the number of passenger pigeons in one flock to be 1,115,136,000 (Wilson and Bonapart, 1831). Featherstonhaugh (1844) remarks about the ". . . . whirring and croaking of tens of thousands of cranes" on a sandbar in the Mississippi River near Herculaneum. Townsend (1839), traveling westward toward the Rocky Mountains in 1834, noticed on the prairies near St. Charles, ". . . . thousands of golden plovers; the ground was often literally covered with them for acres."

With an apparently unending supply of game on every hand it was inevitable that much needless waste and slaughter of animals and birds took place. Indeed, the effects were noticed at an early date. Houck reports that the reduction of game in lower Louisiana was conspicuous as early as 1750. This condition became general as the area became more populated with settlers. James (1823) wrote of his journey across the prairie west of St. Louis in 1820: "The elk, the deer, and the bison, the indigenous inhabitants of these delightful meadows, had long since been driven away by the incursions of the white settlers . . ." Audubon (Audubon & Bachman, 1851), in his travels up the Missouri River in 1843, did not come upon the elk and buffalo until he was a great distance up the river. The settlers and the trader-trappers have always been pointed out as the cause of this great waste. Much of this opinion is doubtless justified. However, in the light of the

current importance given to habitat in relation to animal populations, cannot similar principles be applied, in part, to the great historic reductions of wildlife? Vegetational aspect is the direct expression of geo-, climato-, and bio-relations, and conspicuous changes in floral aspect necessarily are the index of alteration of the habitat. We have noted already that the encroachment of white settlements upon the prairie lands was concurrently accompanied by the reduction of annual burning of the prairies which permitted the establishment of forest trees. A general reduction in fertility and productivity of principal game food sources has also been pointed out and together present such marked changes in the prairie habitat as to reduce seriously the carrying capacity of the area. Reduced in numbers by a decadent habitat, the extinction of major game animals and birds by an ever-increasing settler population was inevitable.

DISCUSSION

An attempt to apply conservation measures of any sort to the Ozarks must take into account that the transition from grassland to trees has been achieved in less than a century and a half. We cannot hope to develop a Bunyanesque kind of forestry in the region so recently invaded by trees. The failure to recognize the non-forest character of the area can only result, as Wilde (1946) indicates, in "a struggle that does not end even when the forest canopy is closed over the prairie soil." It is possible that many of our epidemic tree diseases may stem directly from their growing on a prairie and not a forest soil.

Forestry in the Ozarks can look forward to a multiplicity of problems until adequate time for trial-and-error selection points the way to dependable practices. The successful forestry project will be one which recognizes the fluid conditions prevailing, and is geared to profit by each and every advantage—no matter how unorthodox.

Laws have been enacted which make the firing of timber a criminal action. Fire, perhaps more than any other factor, maintained the prairie and park-like aspect of the Ozarks. But to be effective, the fire season must be long and dry. An increase in precipitation would lessen the effectiveness of fire, and the advancing tree line would suffer fewer disastrous burns. With the advent of white settlements, more and more portions of the area were protected from fire and these in turn furnished a haven for the advancing woodland. During every step of the invasion an increase in precipitation served to reduce the incidence and the damage which fire might cause.

The native backwoodsman (derisively called "ridge runners," "brush apes," etc.), who sets the woods ablaze, is a direct descendant of the first white settler. Without holding a brief for the woods-burner, we may well ask some questions. Is it wise to attempt commercial forestry in an area that averages less than 800 bd. ft. per acre, and when only 10 per cent of the forest supports 2,000 bd. ft. per acre—especially when at least one-third of this forest is in cull trees and trees of non-commercial species? Perhaps a large part of the Ozarks should remain in grass.

The earth works of the Mound Builders have demonstrated the absence of erosion through as much as eight centuries. They were reported at first as almost without trees, then supporting trees, and now in serious danger from erosion. The rainfall which was adequate for grass has increased to the point required by trees. Conservation programs of any character, whether engineering works designed to control floods, efforts to increase game, or simply to farm on a more even keel, cannot ignore the fact that the Ozarks are becoming milder and wetter. No flood-control project can succeed if it does not recognize this climatic change. Major floods in the Mississippi River occur with increasing regularity. The river at St. Louis is much wider than a century ago, and it may be significant that the spring floods in 1950 occurred on a north-to-south line from the Dakotas to Oklahoma. The loss of life and the property damage were aggravated by the fact that this area, without a history of heavy precipitation, was completely unprepared for the heavy rainfall.

An ecological study has shown clearly that the Ozark flora is immature, with the observed associations changing quite rapidly. In addition, the historical accounts of the vegetational character of the area bear out the contention that this is a young and vigorous flora not easily classified. Perhaps many species have disappeared, but one, the Red Cedar, has become more conspicuous by its aggressive pioneering in old fields.

The encroaching forest sounded the death knell of the big game and the game birds. Regardless of hunting pressure, the habitat had deteriorated so rapidly that the herds of game and flocks of birds were doomed. Gun pressure admittedly has increased from the day of the first white settlement. The hunter appeared on the scene and added just the necessary weight to force the game from a habitat which was rapidly becoming untenable. Game management, whether aimed at the increase of deer or the improvement of turkey or quail range, will always be confronted with the present instability of the Ozark weather as expressed by its effect on the vegetational cover. The "Aux Arcs" Mountains, once the habitat of buffalo, elk, and bear, cannot now support turkey under complete protection. A completely stocked forest of pole timber, which makes up 85 per cent of the forest area, is not a habitat for big game or game birds. From a mechanical standpoint, it isn't suitable even for buck deer; a buck with a trophy head will range in the pole timber only under fear and compulsion.

SUMMARY

An imposing list of writings, dating from the earliest travelers, clearly shows the predominance of grass in the Ozark landscape. Featherstonhaugh traveled by horse and buggy from St. Louis to Hot Springs, Arkansas, and the border of Mexico (now Texas). Today such a trip would be impossible except over established highways.

Insufficient time has elapsed to permit any plant association to be termed a climax.

A study of forest resources indicates that today's lumber production, in a favorable market, is far less than the peak which was reached in 1900. Eighty-five per cent of the commercial forest land is classified as "immature," and there is little likelihood of an increase in production in the foreseeable future.

Although very little information is available from Weather Bureau records, some pertinent observations are included which indicate that the Ozarks today enjoy a much milder and wetter climate. The disappearance of salt licks is deemed of considerable significance.

Apparently all factors favoring heavy seed production were present—heavy seed production is not of common occurrence today.

Sufficient information has been gathered to show the extremely important role of fire in the perpetuation of the grassland at the expense of the trees. As early as 1830 the United States Government recognized that the control of fires would clothe the prairies with trees.

The Red Cedar (*Juniperus virginiana*) has shown itself to be a most aggressive invader of the grassland and run-down fields. The beginning of its explosive invasion coincides roughly with reduced burning as a result of an increased population.

Bradbury's observations concerning the Honey Bee leaves little doubt of the open aspect of the country, with the legumes occupying an important position in the flora.

The tremendous quantity of game, easily exceeding that of the domestic cattle and fowl of today, indicates the vast amount of food which was available.

Typical podsolized soils, deemed to be characteristic of forest areas, are unknown in the Ozarks.

Soil erosion, rated as the worst enemy of fertility in the Ozarks, has only recently become important. Ninety years ago the fields in Crawford County were without gulleys. The Indian Mounds stood for centuries before showing signs of erosion.

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